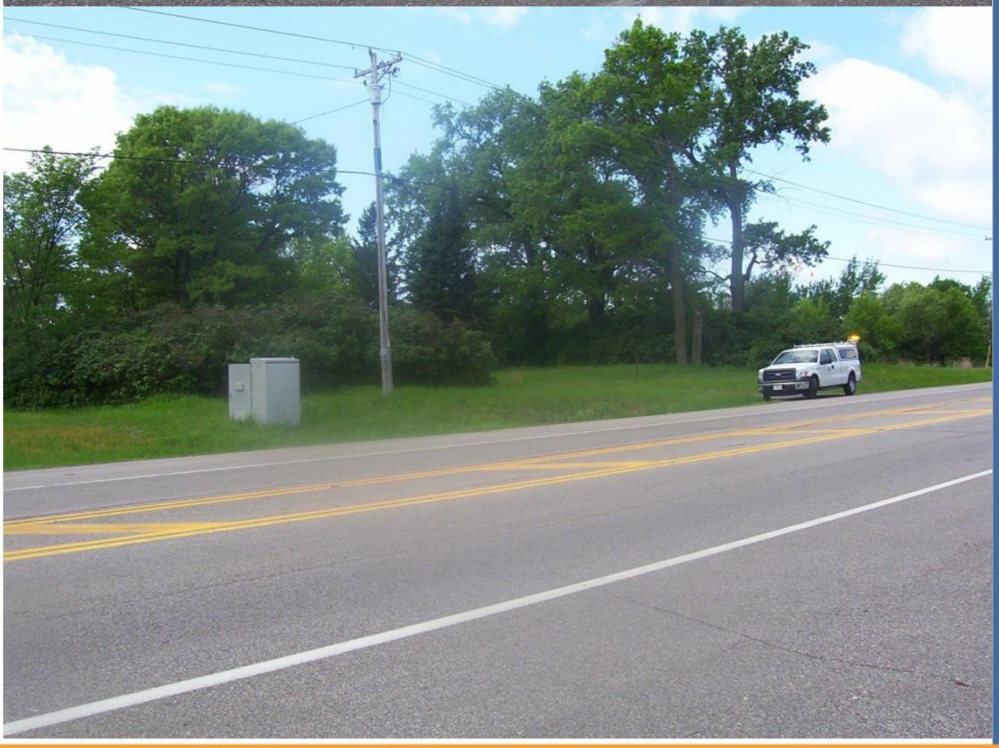
SEPTEMBER 2019



WIM #45
CSAH 14, MP 10.1
BLAINE, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #45 is located on CSAH 14 near Blaine in Anoka county.

System Operation

WIM #45 was operational for the entire month of September 2019. Volume was computed using all monthly data.

System Calibration

WIM #45 was most recently calibrated on 2016-01-19. Table 1 summarizes the front axle weights of class 9s by lane [1]. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation [2]. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 445533 | Passenger Vehicles: 431613 | Heavy Commercial Vehicles: 13920

Monthly Average Daily Traffic (MADT): 15002 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 464

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. EB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays. WB vehicles typically reached highest volume levels on Thursdays, with lowest volumes reported on Sundays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), EB PVs generally reached peak volume levels between 07 AM and 05 PM. Similarly, WB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 07 AM and 05 PM, while volume going WB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 5's and Class 6's.

Overweight HCVs

Volume trends. Of a total of 13920 HCVs, 956 of them were overweight [3]. These overweight HCVs contributed to 0.2% of total monthly volume, and 6.9% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on Sundays. See Figure 3 .
The top two overweight violators by class were the class 6 and class 7 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 55.7% of all overweight vehicles traveling EB this month (see Figure 7 & 8).
Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in June.
WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report [4].
Using normal load limits ,36 EB vehicles exceeded 88,000 pounds (18 vehicles were Class 13's; 13 vehicles were Class 10's). Of vehicles traveling WB,

49 EB vehicles exceeded 88,000 pounds (25 vehicles were Class 10's; 19 vehicles were Class 13's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from September 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in September 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling EB, while there were more fully_loaded Class 9's than empty traveling WB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the EB direction. In the WB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 87342 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (55.5%) than WB (44.5%). See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 02051 (a prestressed concrete beam span) is approximately 2.8 miles west of WIM #45 on CSAH 14, and Bridge No. 02006 (a prestressed concrete beam span) is approximately 5.2 miles east of WIM #45 on CSAH 14. WIM #45 recorded a total of 445533 vehicles with a combined GVW of 2328115 kips (1 kip = 1,000 pounds = 0.5 tons) in September 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 6713 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 55.5% of all ESALs were recorded EB while 44.5% was observed WB. In particular, 32% of all ESALs were generated by the Class 5's (Class 5's were also responsible for generating 6% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at: http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at: http://www.dot.state.mn.us/traffic/data/data-products.html#weight

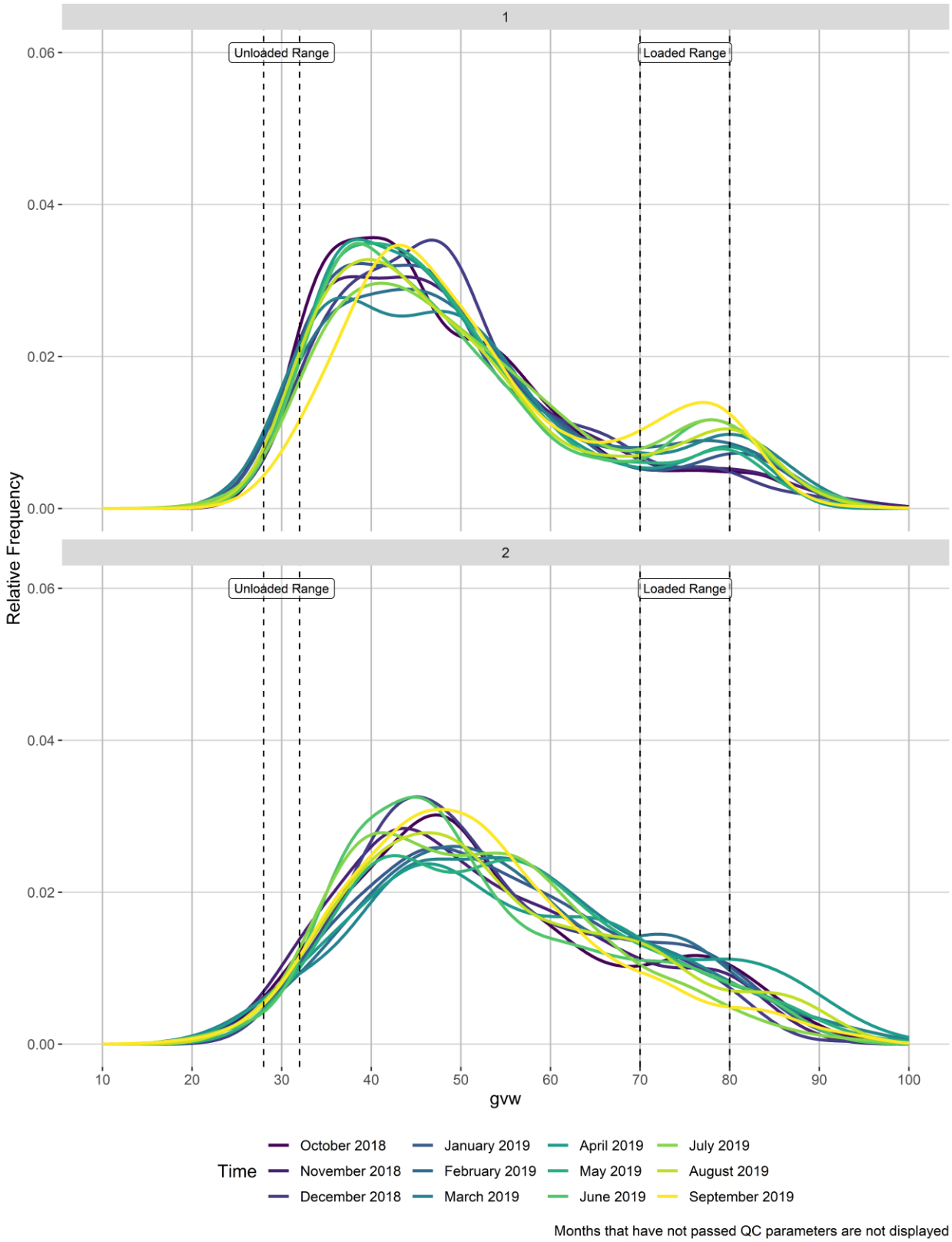
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [2] Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.

- [3] An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp

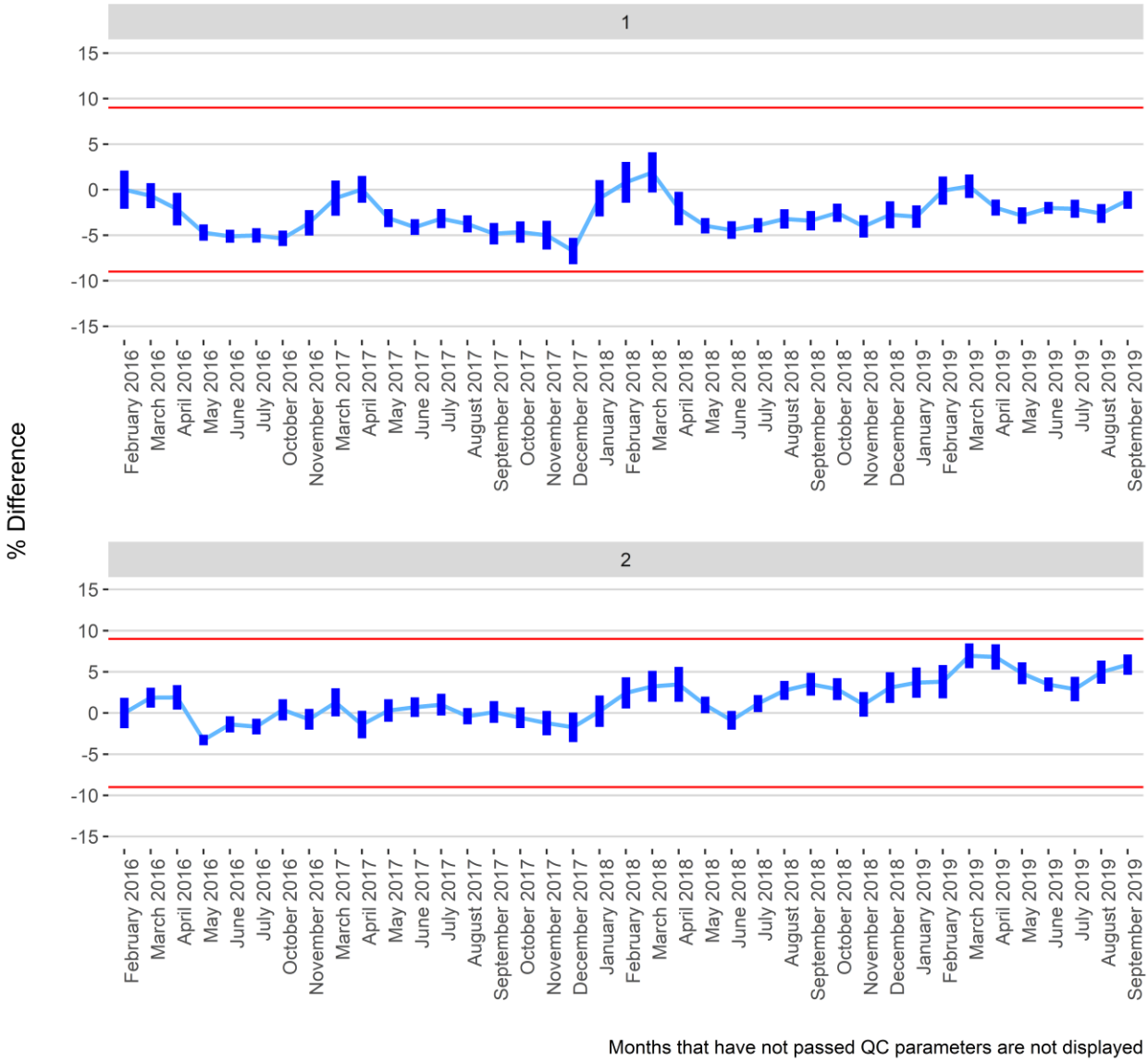
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume vs. Day of the Week

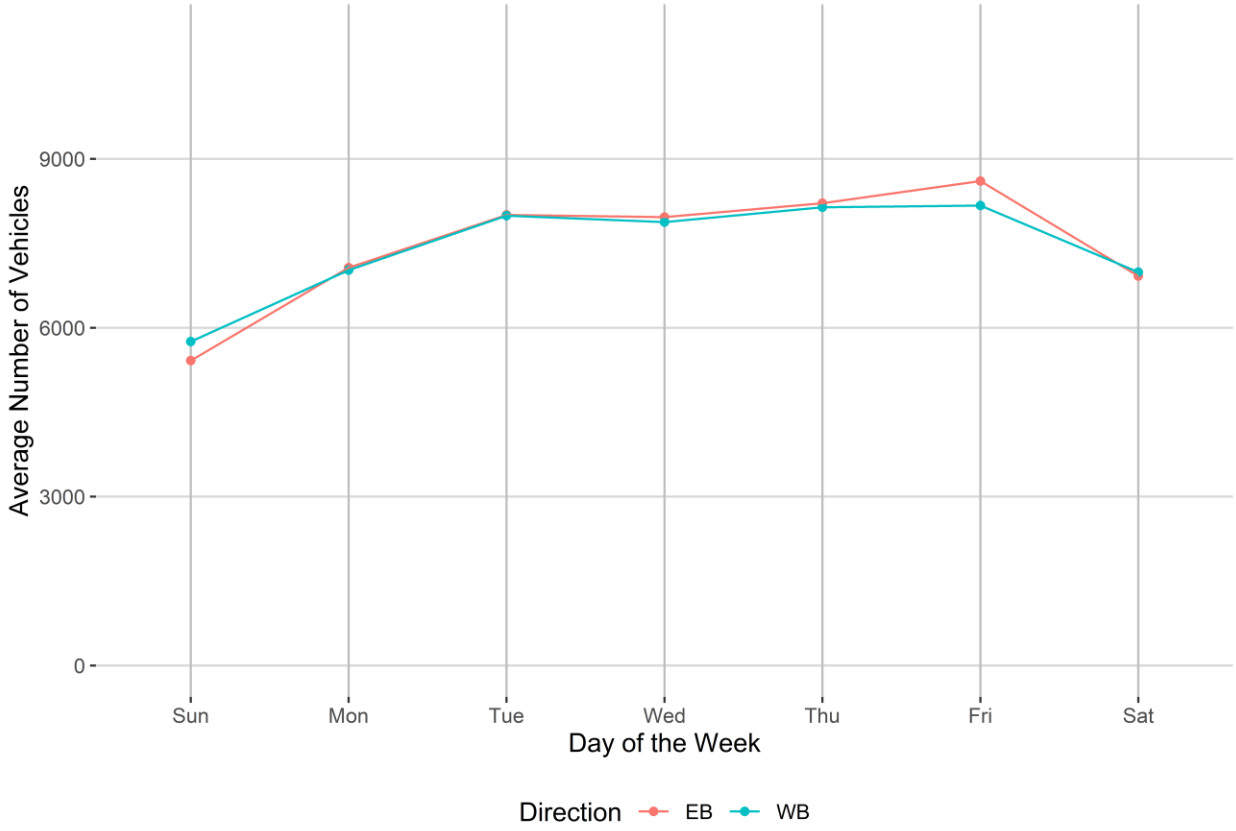


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

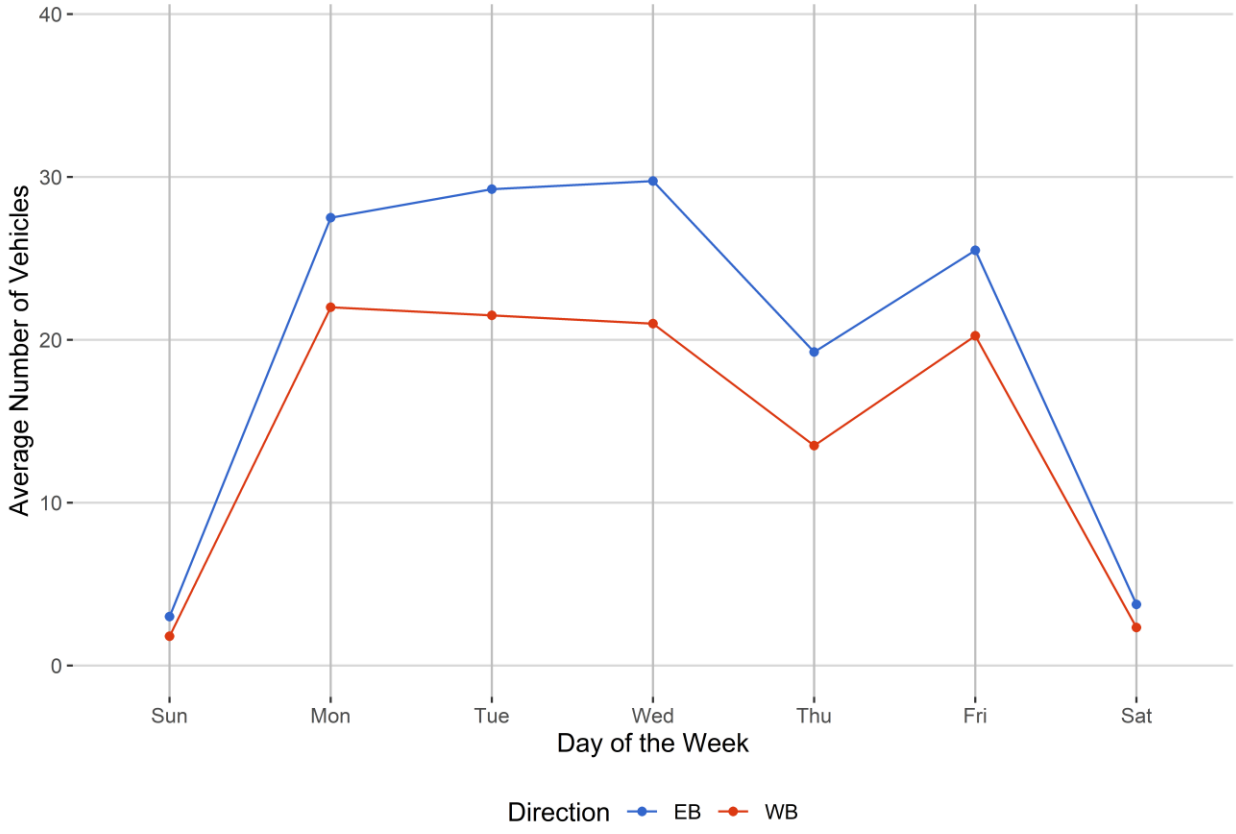


Figure 4 - Passenger Vehicles vs. Hour of the Day

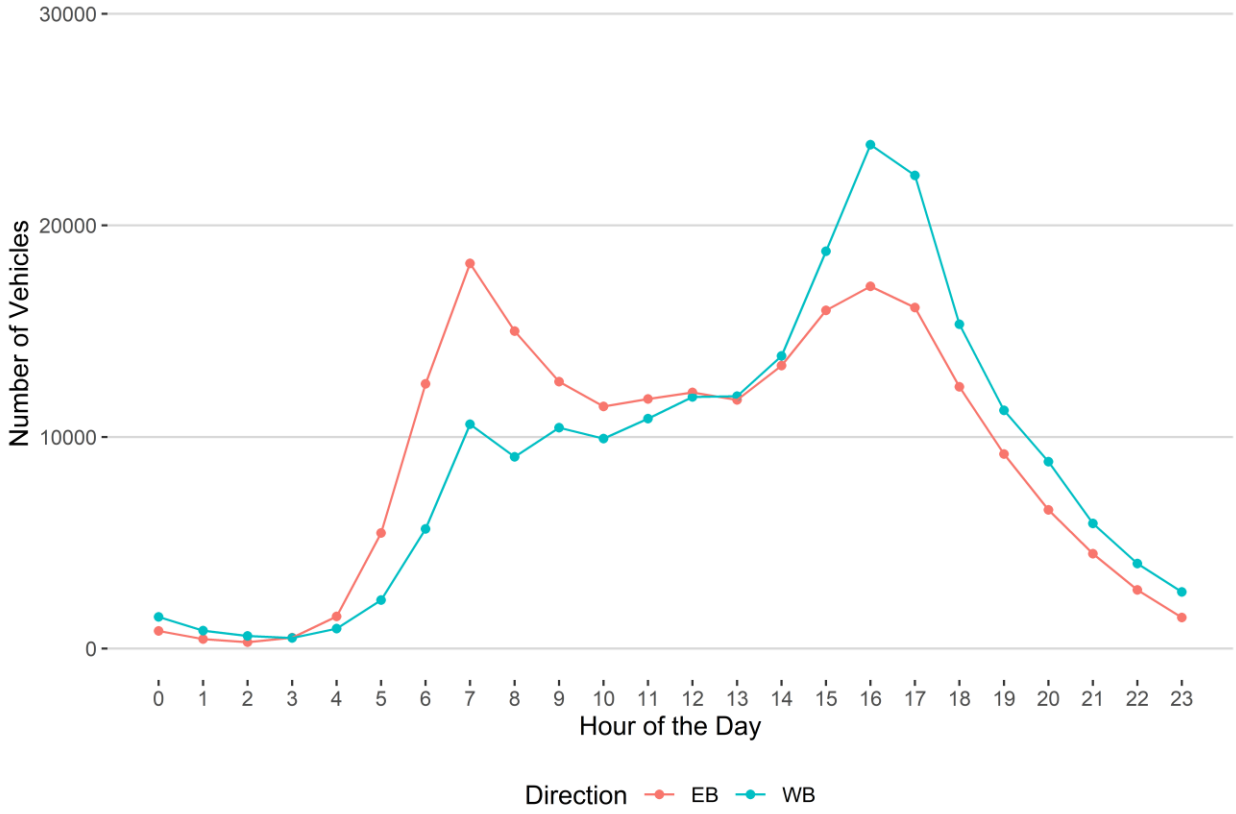


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

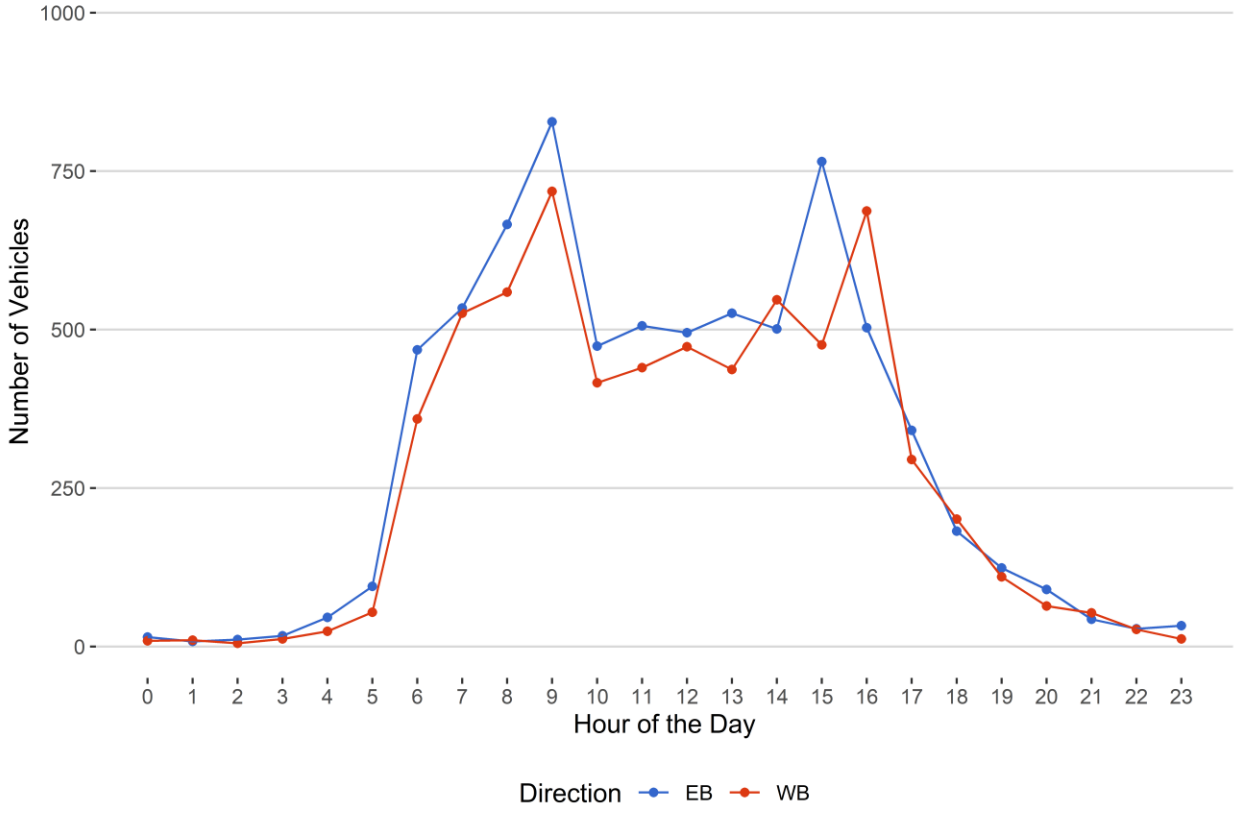


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

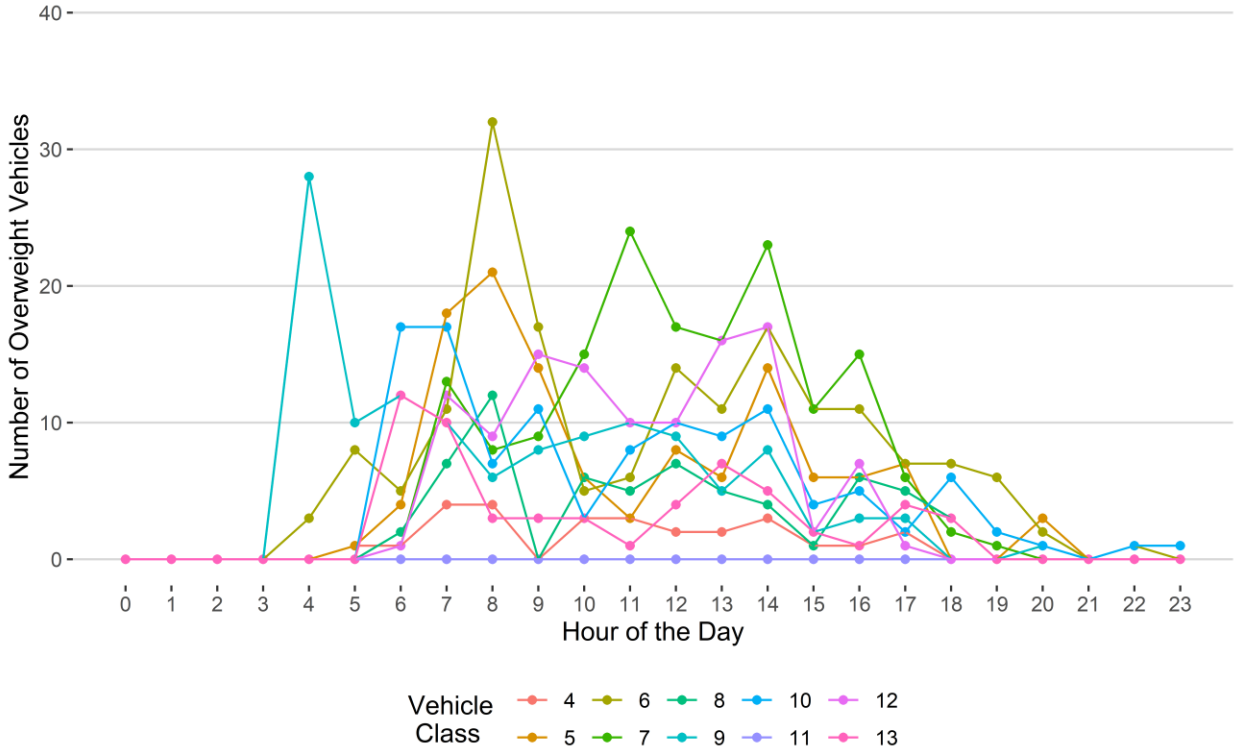


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

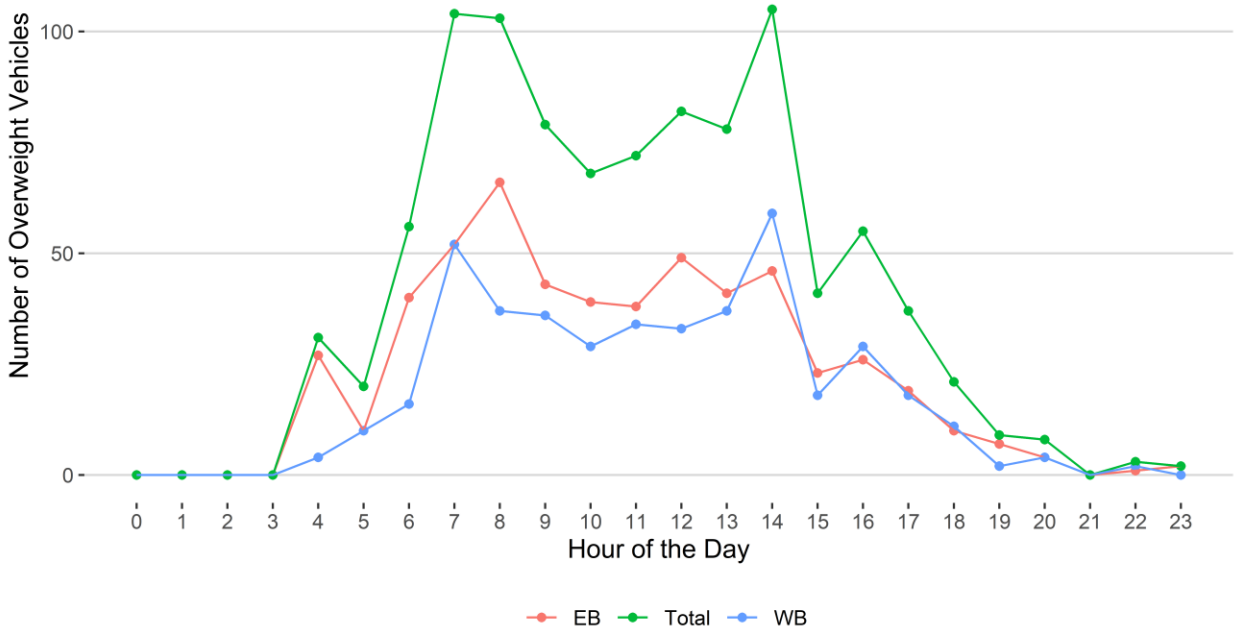
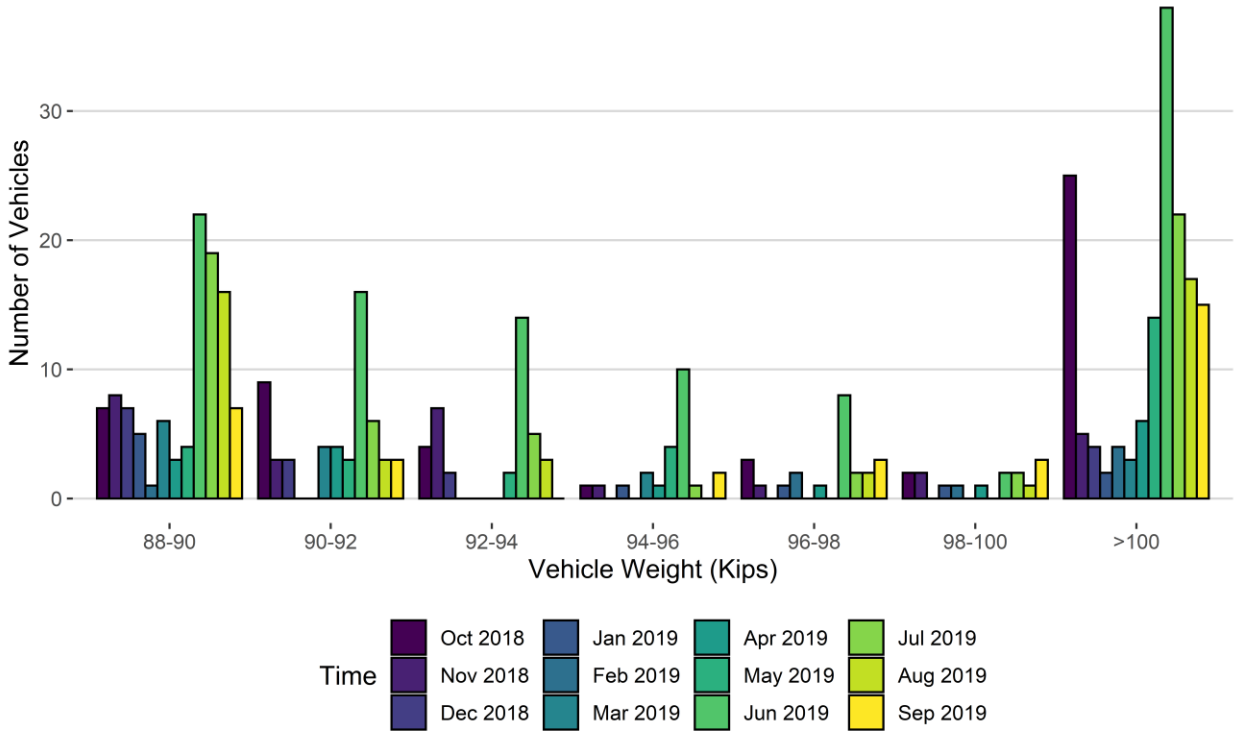
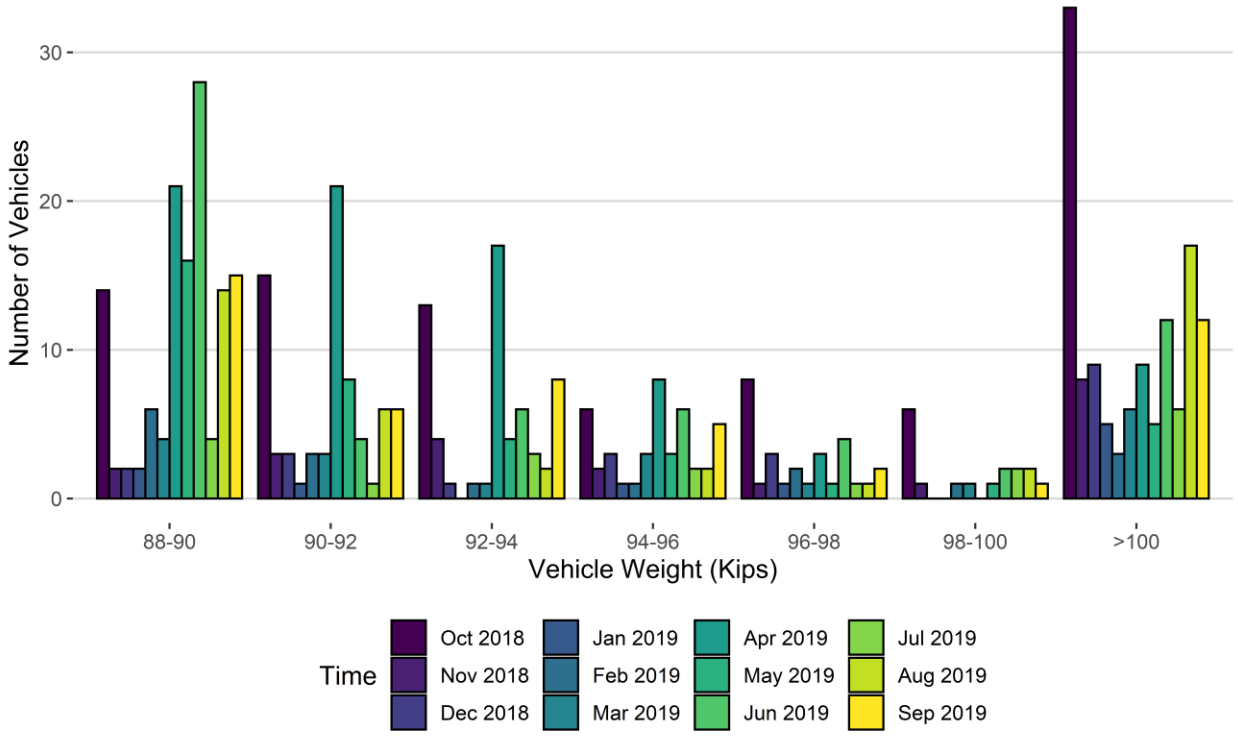


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*	*Aug 2019*	*Sep 2019*
88-90	7	8	7	5	1	6	3	4	22	19	16	7
90-92	9	3	3	0	0	4	4	3	16	6	3	3
92-94	4	7	2	0	0	0	0	2	14	5	3	0
94-96	1	1	0	1	0	2	1	4	10	1	0	2
96-98	3	1	0	1	2	0	1	0	8	2	2	3
98-100	2	2	0	1	1	0	1	0	2	2	1	3
>100	25	5	4	2	4	3	6	14	38	22	17	15
Total	51	27	16	10	8	15	16	27	110	57	42	33

Figure 8 - Histogram of WB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*	*Aug 2019*	*Sep 2019*
88-90	14	2	2	2	6	4	21	16	28	4	14	15
90-92	15	3	3	1	3	3	21	8	4	1	6	6
92-94	13	4	1	0	1	1	17	4	6	3	2	8
94-96	6	2	3	1	1	3	8	3	6	2	2	5
96-98	8	1	3	1	2	1	3	1	4	1	1	2
98-100	6	1	0	0	1	1	0	1	2	2	2	1
>100	33	8	9	5	3	6	9	5	12	6	17	12
Total	95	21	21	10	17	19	79	38	62	19	44	49

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

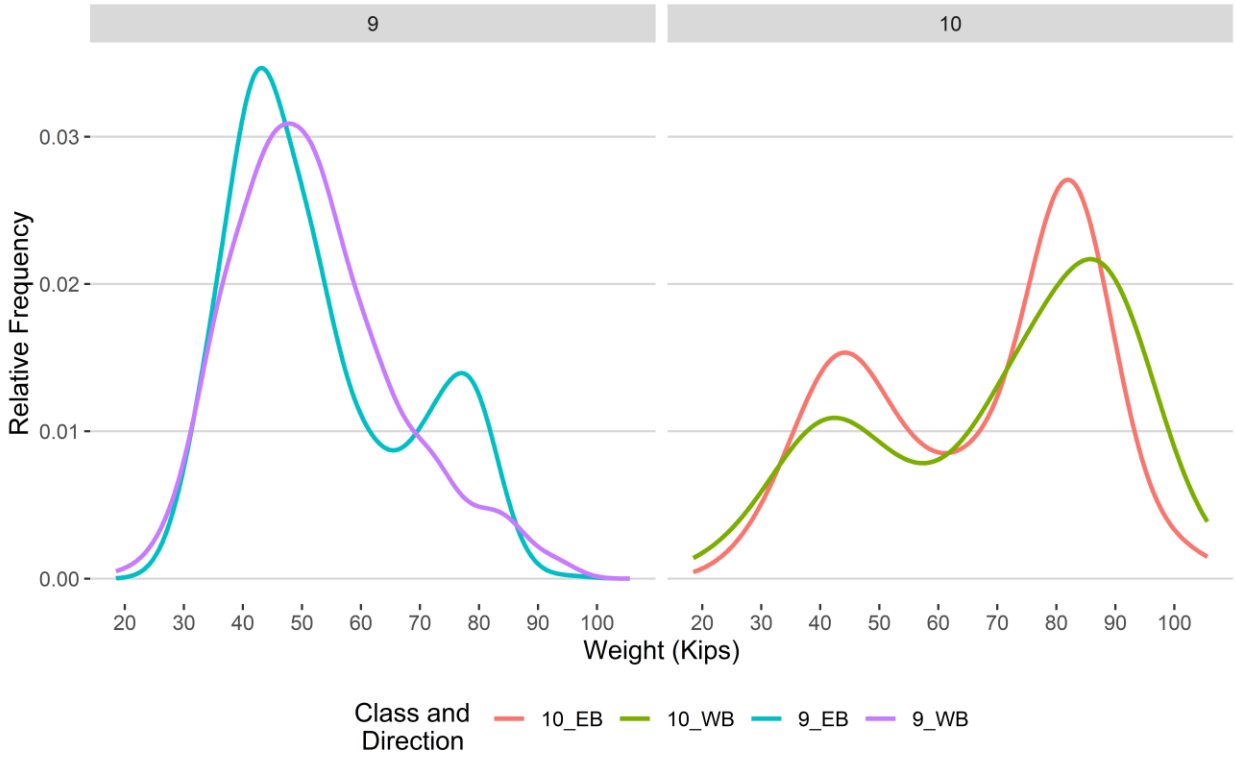


Figure 9 - Freight Percentage by Direction and Class

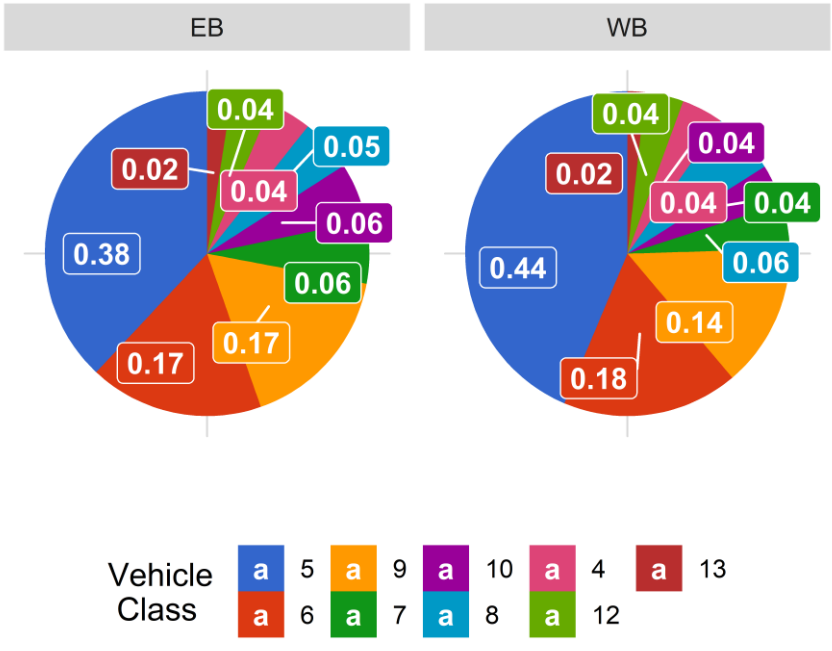


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

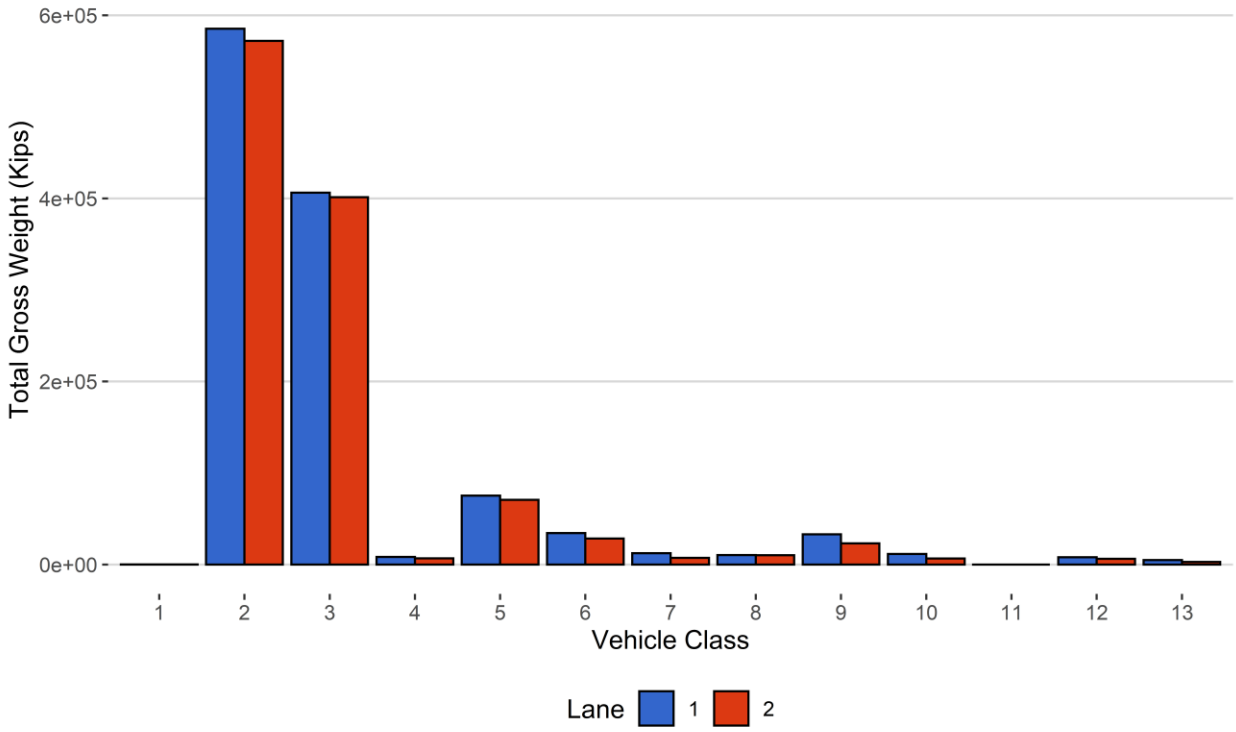
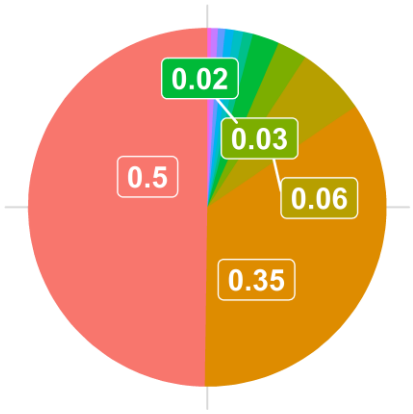


Figure 11 - Total Gross Vehicle Weight b



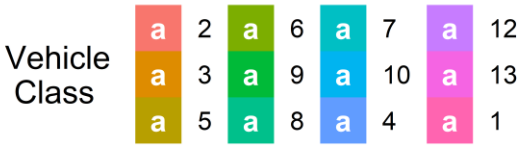


Figure 12 - Total ESALs by Class and Lane

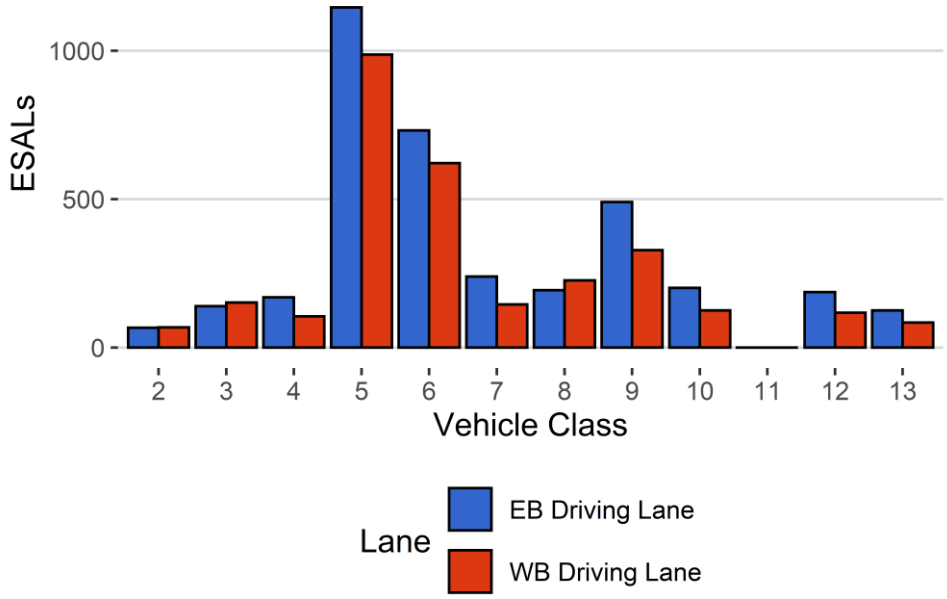


Figure 13 - ESALs by Class

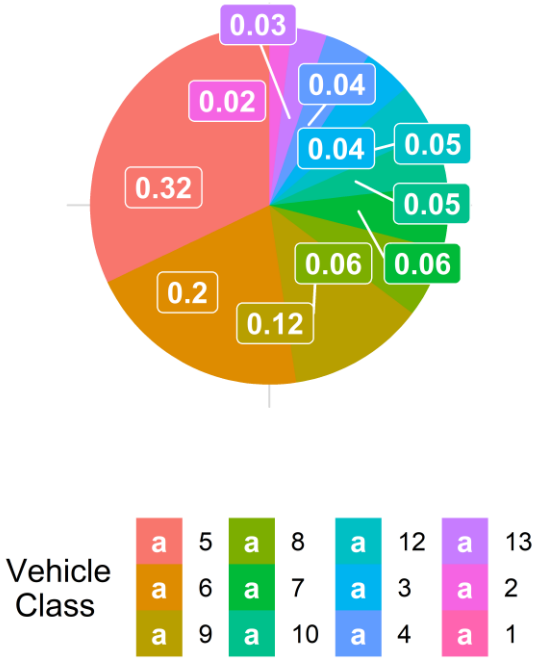


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
February 2016	11.29	0.00	10.54	0.00
March 2016	11.21	-0.66	10.73	1.86
April 2016	11.05	-2.13	10.74	1.89
May 2016	10.75	-4.71	10.19	-3.28
June 2016	10.71	-5.12	10.39	-1.38
July 2016	10.72	-5.02	10.36	-1.66
October 2016	10.68	-5.35	10.58	0.39
November 2016	10.87	-3.64	10.46	-0.76
March 2017	11.18	-0.93	10.67	1.29
April 2017	11.29	0.03	10.39	-1.41
May 2017	10.93	-3.13	10.57	0.31
June 2017	10.82	-4.11	10.61	0.71
July 2017	10.93	-3.18	10.65	1.01
August 2017	10.86	-3.76	10.50	-0.39
September 2017	10.74	-4.84	10.55	0.11
October 2017	10.76	-4.66	10.48	-0.58
November 2017	10.72	-5.00	10.41	-1.23
December 2017	10.53	-6.74	10.36	-1.74
January 2018	11.18	-0.95	10.56	0.22
February 2018	11.38	0.81	10.80	2.44
March 2018	11.50	1.90	10.88	3.23
April 2018	11.05	-2.07	10.90	3.47
May 2018	10.84	-3.96	10.64	0.98
June 2018	10.79	-4.43	10.44	-0.89
July 2018	10.84	-3.91	10.66	1.15
August 2018	10.92	-3.22	10.83	2.74
September 2018	10.90	-3.41	10.91	3.49
October 2018	11.00	-2.54	10.84	2.90
November 2018	10.83	-4.03	10.65	1.04
December 2018	10.97	-2.76	10.86	3.08
January 2019	10.95	-2.96	10.93	3.69
February 2019	11.27	-0.11	10.94	3.80
March 2019	11.33	0.37	11.27	6.95
April 2019	11.06	-1.97	11.26	6.80
May 2019	10.96	-2.85	11.05	4.82
June 2019	11.06	-2.00	10.90	3.46
July 2019	11.05	-2.10	10.84	2.90
August 2019	10.99	-2.62	11.06	4.96
September 2019	11.16	-1.14	11.16	5.87

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
1	9	261	0.1	0	0
2	9869	296084	66.5	0	0
3	4509	135268	30.4	0	0
4	17	510	0.1	28	2.9
5	303	9098	2	117	12.2
6	58	1739	0.4	174	18.2
7	10	306	0.1	161	16.8
8	22	647	0.1	63	6.6
9	36	1080	0.2	126	13.2
10	9	266	0.1	115	12
11	0	0	0	0	0
12	6	190	0	114	11.9
13	3	83	0	58	6.1
TOTAL	**14851**	**445533**	**100**	**956**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-09-18	Wednesday	09:09:01	10	WB	2	105.58
2019-09-20	Friday	06:32:27	10	WB	2	104.66
2019-09-28	Saturday	09:22:21	10	EB	1	103.52
2019-09-24	Tuesday	09:36:31	10	EB	1	103.28
2019-09-21	Saturday	18:13:14	10	EB	1	99.72
2019-09-17	Tuesday	16:51:44	10	EB	1	97.38
2019-09-20	Friday	14:02:03	10	EB	1	97.2
2019-09-23	Monday	12:49:32	10	WB	2	96.15
2019-09-20	Friday	13:05:21	9	EB	1	95.16
2019-09-06	Friday	14:40:29	10	WB	2	94.87

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	EB	15	267	37	13.9	7756	489	2153
5	EB	8	4608	311	6.7	73001	2241	19313
6	EB	19	953	9	0.9	34177	152	8121
7	EB	11.5	194	0	0	12436	0	5103
8	EB	31	319	149	46.7	7540	2802	1135
9	EB	33	626	25	4	32188	780	6178
10	EB	33.5	171	5	2.9	11318	150	2878
12	EB	36.5	108	0	0	8002	0	2030
13	EB	31.5	53	0	0	4852	0	1591
TOTAL	****	****	**7299**	**536**	****	**191270**	****	**48501**
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	WB	15	239	28	11.7	6313	386	1574
5	WB	8	4420	221	5	69111	1538	17759
6	WB	19	773	9	1.2	28221	149	6853
7	WB	11.5	110	0	0	7267	0	3001
8	WB	31	323	170	52.6	6905	3252	1081
9	WB	33	446	23	5.2	22490	668	4265
10	WB	33.5	93	4	4.3	6420	110	1719
12	WB	36.5	81	0	0	6231	0	1637
13	WB	31.5	29	0	0	2818	0	952
TOTAL	****	****	**6514**	**455**	****	**155775**	****	**38842**
GRAND TOTAL	****	****	**13813**	**991**	**155**	**347045**	**12716**	**87342**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*EB*	*WB*	*Total*	*Percentage*
1	146	124	271	0
2	585338	572039	1157377	49.8
3	406285	401267	807552	34.7
4	8245	6699	14943	0.6
5	75242	70649	145890	6.3
6	34329	28371	62699	2.7
7	12436	7267	19703	0.8
8	10341	10157	20498	0.9
9	32969	23158	56127	2.4
10	11468	6530	17998	0.8
12	8002	6231	14232	0.6
13	4852	2818	7669	0.3
TOTAL	**1189653**	**1135309**	**2324962**	**100**
GVW/LANE	**51.17**	**48.83**	**100**	**0**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*EB*	*WB*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0.0038
2	67	68	135	2	9e-04
3	139	152	291	4.4	0.0044
4	169	105	275	4.1	1.09
5	1146	987	2133	32.1	0.48
6	732	621	1353	20.3	1.58
7	240	145	385	5.8	2.52
8	194	226	420	6.3	1.31
9	490	329	819	12.3	1.53
10	201	125	326	4.9	2.44
12	187	118	304	4.6	3.11
13	126	85	210	3.2	4.6
TOTAL	**3690**	**2961**	**6651**	**100**	**19**
ESALS/LANE	**55.5**	**44.5**	**100**	**–**	**–**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*
Oct 2018	444856	14350	511	429029	96.4	15827.1	3.6
Nov 2018	398210	13274	359	387448	97.3	10761.7	2.7
Dec 2018	387498	12500	313	377791	97.5	9706.9	2.5
Jan 2019	367731	11862	300	358419	97.5	9311.5	2.5
Feb 2019	343809	12279	328	334638	97.3	9170.8	2.7
Mar 2019	385777	12444	286	376903	97.7	8874.2	2.3
Apr 2019	420217	14007	355	409564	97.5	10653.3	2.5
May 2019	484371	15469	467	469906	97	14465.4	3
Jun 2019	447421	14914	380	436036	97.5	11385.3	2.5
Jul 2019	404321	12901	335	393924	97.4	10396.9	2.6
Aug 2019	416566	13437	356	405520	97.3	11045.9	2.7
Sep 2019	445533	15002	464	431613	96.9	13919.9	3.1
TOTAL	**4946310**	**–**	**–**	**4810791**	**–**	**135519**	**–**
AVERAGE	**412192**	**13537**	**371**	**400899**	**97**	**11293**	**3**

###ESALs

Month	*ESALS EB Driving Lane*	*ESALS WB Driving Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Oct 2018	4012	4294	8306	7.2
Nov 2018	2509	2284	4793	3.1
Dec 2018	2365	2179	4544	1.6
Jan 2019	2057	1877	3933	1.3
Feb 2019	2201	2100	4301	1.1
Mar 2019	2197	1698	3894	2.1
Apr 2019	2374	2514	4888	15.4
May 2019	3494	3224	6717	4.3
Jun 2019	6067	4480	10547	6.4
Jul 2019	3071	1861	4932	4
Aug 2019	2786	2746	5532	3.7
Sep 2019	3726	2987	6713	2.1
TOTAL	**36857**	**–**	**–**	**–**
AVERAGE	**3071**	**2687**	**5758**	**4**

###Gross Vehicle Weight

Month	*GVW EB Driving Lane*	*GVW WB Driving Lane*	*Total GVW Kips*
Oct 18	1261947	1190018	2451966
Nov 18	1022767	962848	1985615

Dec 18	996068	942253	1938320
Jan 19	928842	879765	1808607
Feb 19	893522	831150	1724672
Mar 19	1002496	848116	1850612
Apr 19	1090589	993366	2083955
May 19	1300770	1199019	2499789
Jun 19	2470166	2048533	4518699
Jul 19	1170043	874938	2044980
Aug 19	1057506	1074847	2132353
Sep 19	1190943	1137172	2328115
TOTAL	**14385661**	**12982023**	**27367684**
AVERAGE	**1198805**	**1081835**	**2280640**

###Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
Oct 2018	1310	0.3	7.8	148	66
Nov 2018	615	0.2	5.6	48	16
Dec 2018	693	0.2	7	37	13
Jan 2019	492	0.1	5.2	20	8
Feb 2019	553	0.2	5.9	27	11
Mar 2019	470	0.1	5.1	34	10
Apr 2019	638	0.2	5.8	95	16
May 2019	999	0.2	6.8	66	20
Jun 2019	1566	0.2	6.8	172	54
Jul 2019	761	0.2	7.2	76	32
Aug 2019	939	0.2	8.4	86	37
Sep 2019	974	0.2	6.9	85	32
TOTAL	**10010**	**–**	**–**	**894**	**315**
AVERAGE	**834.2**	**0.2**	**6.5**	**74.5**	**26.2**

###Freight

Month	*EB Freight Tons*	*WB Freight Tons*	*Total Freight*	*EB Freight %*	*WB Freight %*
Oct 2018	52534	62656	115190	45.6	54.4
Nov 2018	32474	29307	61781	52.6	47.4
Dec 2018	31218	27144	58362	53.5	46.5
Jan 2019	25566	23173	48739	52.5	47.5
Feb 2019	25807	22634	48441	53.3	46.7
Mar 2019	26399	20405	46803	56.4	43.6

Apr 2019	30513	29739	60251	50.6	49.4
May 2019	45606	43096	88702	51.4	48.6
Jun 2019	76795	58724	135519	56.7	43.3
Jul 2019	39281	23158	62440	62.9	37.1
Aug 2019	35223	33847	69070	51	49
Sep 2019	48501	38842	87342	55.5	44.5
TOTAL	**469917**	**412724**	**882640**	**–**	**–**
AVERAGE	**39159.7**	**34393.6**	**73553.4**	**53.5**	**46.5**